FORTY-THIRD ANNUAL REPORT
FOR THE CALENDAR YEAR 1953

- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula Montana

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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FORTY-THIRD ANNUAL REPORT

Progress on major forest and range research problems is often hard to measure in the space of one short year. Significant gains were made in 1953, however, at the Northern Rocky Mountain Station--gains in terms of increased knowledge and from improvements in the pattern of the research organization itself. The research year has been more or less normal with some new problems and some critical events to emphasize the need for more research information. The spruce bark beetle epidemic and timber salvage program demanded better information on utilization practices. Declining beef prices and meat surpluses put a premium on efficient ranch and range management and the know-how required to survive in the present economic atmosphere. A worse-than-average fire season, after a dozen easy years, focused attention again on problems that require more research for their solution. Progress on these and other problems made the research year a profitable one.

The 1953 Fire Season

Concentrations of lightning fires often characterize severe fire seasons in the northern Rockies and create fire loads that overtax normal organization. The 1953 season, while not as bad as some, had periods of high lightning fire occurrence. The year's total was 1358 lightning fires, 1028 of which occurred in August, an all-time record for that month by a considerable margin.

Ten or twenty years ago we accepted lightning fires as natural phenomena, the prevention of which was beyond human capabilities. Recent scientific advances indicate such may no longer be true--that lightning storm modification is within the realm of possibilities.

This year, in cooperation with the Munitalp Foundation, Inc., encouraging progress was made in studies of fundamental meteorology and cloud physics. Preliminary results were obtained from project "Skyfire," described in detail on later pages, that may lead to effective modification of fire-starting lightning storms.

Impact of Large Dams on Forest Resource Development

The abundant water resources of the northern Rockies can contribute much to the economy of the Pacific Northwest. During the past two years three such projects have been completed in northern Idaho and western Montana. Others are planned or are already under construction. The value of these projects in terms of power production, flood control, and irrigation benefits cannot be questioned. Nevertheless, their impact on resource development and use and on other aspects of local welfare can be significantly harmful unless adequate measures are taken to minimize their effects. When a large reservoir is constructed in a major mountain valley it not only floods valuable bottomland but it closes for all time the most natural transportation routes. Usually few desirable alternatives are available for the railroads, highways,

and spur roads required for resource development. Transportation problems often lessen opportunities for industrial development, reduce payrolls, prevent use of timber on an efficient basis, or have other impacts.

During the year a notable study of the impact of the proposed Libby Dam was completed by the Forest Service in cooperation with the U. S. Army Corps of Engineers. This study was significant because it pioneered a new approach to dam planning--an approach that goes far beyond the simple philosophy of "replacement in kind." In the study, several plans were compared with full recognition given to problems of national forest administration, costs of logging, and worker income, as well as public transportation, recreation, and other factors. The study shows that replacement in kind can produce impacts far more costly than a more adequate restoration of facilities.

Insect and Disease Problems in Relation to Forest Management

The prevalence of insect and disease problems in northern Rocky Mountain forests is well known. The preponderance of overmature stands in many areas creates favorable environments for the buildup of epidemics. In other cases, introduced diseases, like white pine blister rust, become firmly established in forests of all ages.

Regardless of the type of pest or its origin, effective control will rest eventually on sound forest management and the creation of environments unfavorable for the development of insects and diseases. Consequently, one of the most important longtime jobs for the forest management research worker is to develop silvicultural and management principles and techniques commensurate with the requirements of sound insect and disease control. Progress was made in this direction during the year through the publication of U.S.D.A. Circular 919, "Aiding Blister Rust Control by Silvicultural Measures in the Western White Pine Type," a cooperative endeavor with the Bureau of Entomology and Plant Quarantine.

An outstanding significance at year's end was an internal adjustment, within the Department of Agriculture, which transferred forest insect and disease research from other bureaus[1/] to the Forest Service. The change brings together all phases of research on forest pests. The insect and disease work will be organized on a divisional basis in the forest experiment stations but the important tie with silviculture and management studies can now be made completely effective. The control of bark beetles, defoliators, mistletoes, blister rust, and other pests will get an increasingly effective assist from forest management.

Engelmann Spruce Bark Beetle Epidemic

The bark beetle epidemic, threatening 15 billion board feet of Engelmann spruce in the northern Rocky Mountain forests, continued to make news in 1953. The control of beetles, primarily by logging infested timber,

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1/ Insect investigations and pest surveys from the Bureau of Entomology and Plant Quarantine and the Division of Forest Pathology from the Bureau of Plant Industry, Soils, & Agricultural Engineering.

required tremendous step-up of spruce lumber manufacture and, in turn, emphasized problems connected with processing and utilization of the species. Heretofore, about 50 million board feet of spruce lumber have gone to consumers each year from the Region. In 1953 a goal of about 275 million was set.

Two types of problems requiring research aid resulted from the sudden expansion in spruce utilization. First, many manufacturers unfamiliar with handling spruce, or others with speed-up programs, encountered technical and managerial problems in the lumber mills. These ranged all the way from grade recovery from partially deteriorated logs to drying schedules and machine speeds for finishing lumber. The second problem related to marketing, what had been a little-used species in many localities, in greatly expanded volumes. Additional knowledge of properties and uses was required. Many agencies cooperated in getting answers to these questions, as later described. The local Forest Utilization Service and the Forest Products Laboratory were prominent in obtaining the facts needed by industry.

The Livestock Situation and Range Research

The year saw an extremely critical situation develop in the range-livestock industry with too many breeding animals, a falling market, support prices on feed grains, and high retail beef prices. The drought in Texas and the Southwest complicated the picture further. The difficulty in which many cattlemen found themselves, however, is much more deeply seated. Favorable markets and the strong consumer demands of recent years have not been conducive to the most efficient ranch and range management. In some cases at least, breeding herds have been increased and maintained at high levels. The same income and production could undoubtedly have been reached with fewer but better animals.

Range research at Miles City and Vigilante again demonstrated that good management means high income. The Miles City study showed again that heavy stocking reduces calf crops, beef production in terms of weaned calves, and increases costs of production. Also, it showed that too-heavy stocking produces breeding cows of reduced mature carcass size, which in turn means that more animals are required to produce a given amount of beef. As animal numbers go up, all other operations and costs increase accordingly and, even more important, the range situation gets progressively worse and a vicious cycle evolves from which there is only one exit--dwindling profits and range deterioration.

The scope of our range research has been reduced by the recent internal reorganization of the Department of Agriculture. All work previously done at our Northern Great Plains research center at Miles City, Montana, has been transferred to the Agricultural Research Service. Likewise, all reseeding research and studies of noxious plant control will be handled by that Bureau. Though a curtailment in range research done by the Forest Service, the reorganization represents a realignment along functional lines that is intended to prevent unnecessary duplication of research effort in these fields. The new Bureau will continue studies already underway and assume future responsibility for new work in the fields transferred.

Station Consolidation

More effective on-the-ground research can be expected following the consolidation of the Northern Rocky Mountain and the Intermountain Forest and Range Experiment Stations January 1, 1954. The enlarged station will bear the name "Intermountain Forest and Range Experiment Station." Headquarters will be in Ogden, Utah, chosen because of its central location for the broad program in Utah, Nevada, western Wyoming, Idaho, Montana, and eastern Washington.

Advantages of the merger are numerous but foremost is the strengthening of technical programs made possible by savings in overhead and business office streamlining. Heretofore, the two stations were small and neither had the base for effective research administration. The research done by project workers at centers such as Spokane and Missoula and at experimental forests such as Priest River, Deception Creek, Coram, and Vigilante will be unaffected. Some new research can be started and a better balance in programs will result. It is expected that research in the important watershed management field can be started in the northern Rockies as a result of the merger.

The station consolidation brings to a close this series of annual reports for the Northern Rocky Mountain Station. On the following pages, however, is a detailed discussion of accomplishments of 1953 and plans for 1954. Progress on the latter will be reported as part of the Intermountain Station's report next year.

Division of Forest Economics Research

A. Accomplishments in 1953

Economics of Forest Management, Utilization, and Marketing

Adverse impacts of a dam upon the local economy are costs of that dam just as much as are costs of physical construction. This point is emphasized in a recently released report "Impact of the Proposed Libby Dam Upon the Forest Economy of Lincoln County, Montana." This report is the result of a year-and-a-half study. Financed mainly by the Army Engineers, this study was a cooperative undertaking of the regional office of the Forest Service and this experiment station. Actual work was done by a four-man study team consisting of a forester, road engineer, logging engineer, and forest economist.

This report is an important milestone in resource planning. Thoroughly exploring the problems of managing and developing the forest resource behind this dam, it shows that a poor job of transplanting the transportation arteries which would be flooded by the dam would throw the local economy into a severe state of shock. Two different locations for the dam were considered. In both instances it was possible to develop post-dam transportation plans which would hold the adverse local impacts to a minimum and provide the most economical solution to the overall resource development problem.

As an outgrowth of the Libby Dam study, a paper "Problems of Resource Development Associated with the Construction of Large Dams" was delivered before the Pacific Northwest Trade Association in Spokane on November 2.

Forest Industry Analysis

The development of a sound forest industry based upon good conservation practices is being urged. Members of this division have chairmanned two committees in the Montana Conservation Council. One, the New Industries Committee, has as its main project the development of an adequate state policy for control of stream pollution. This problem has strong forestry overtones in Montana as water pollution is one of the main problems associated with pulpmill development.

The other committee is the so-called "Caravan Committee" which is responsible for the annual Conservation Caravan. The 1954 caravan will be a one-week trip through western Montana studying the natural resources. About forty teachers, bankers, lawyers, and other lay people will make the tour.

Other activities in this field consisted of the presentation of a paper "The Spruce Bark Beetle in the Northern Rocky Mountain Region," at the annual Industrial Waste Conference in Pullman, Washington, during March. An article on the Montana Christmas tree industry was prepared for the Christmas issue of the Lake States Timber Digest.

During 1952 the production of poles was about 6 percent greater than in 1951, according to the annual pole production survey in the northern Rocky Mountain region. The 1952 total amounted to 494,152 poles as compared with 465,347 produced in 1951.

Montana shipped fewer Christmas trees in 1952 than in any one of the four previous years. A study of the 1952 Christmas tree business revealed that the 2,644,600-tree total was 14 percent below the 3,084,540 trees shipped in 1951 and 20 percent below the peak year of 1946.

Sampling surveys to obtain estimates of the production of timber products were completed for the region. Sufficient data were collected to provide production estimates for each of the several timber products coming from the forests of this area. Along with production data, information on utilization of mill residues was gathered. All of this information is needed to keep forest survey data current.

Forest Resource Analysis

Eighty-one percent of North Idaho is forest land; 76 percent of the forest has commercial value; 54 percent of the total sawtimber volume is in trees below 21 inches in diameter. Such are some of the findings of the resurvey of North Idaho. Compilation of data for the reinventory of North Idaho has been completed and a statistical report is now being processed.

Forest Survey

The pace of the forest inventory of south Idaho was stepped up considerably during 1953 and slightly more than 3½ million acres of forest land were covered in the field. Field work on the cooperative survey being made in southwest Idaho was completed this fall and good progress is being made on the compilation phase of the job. This year the State Forest Service entered into this cooperative undertaking.

As of December 31, 1953 the field work had been completed on 4,525,000 acres of commercial forest land, 1,333,000 acres of noncommercial forest land, and 900,000 acres of reserved forest land. This total of 6,758,000 acres represents about 63 percent of the total forest area of south Idaho.

Nearly 1½ million acres of forest land were inventoried last summer as a part of the resurvey of Montana. A small start was made on this resurvey in 1952 when 105,000 acres of forest land in Lincoln County were covered. This year's accomplishment brings the total area covered in Lincoln County to 1,600,000 acres or about 8 percent of the forest land of the entire state.

B. Plans for 1954

Economics of Forest Management, Utilization, and Marketing

An analysis will be made of the economic problems in forestry of the combined Northern Rocky Mountain and Intermountain areas and study priorities will be set up. A study plan will be prepared and a start made to determine the cost of growing timber in these areas.

Forest Industry Analysis

Compilation work will be completed for the sampling surveys made during 1953 of production of timber products. Reports on the various products will be issued during 1954.

Forest Resource Analysis

As field work on the forest inventory of south Idaho nears completion we will start collecting related basic information essential to the interpretation of forest survey data. This information will be needed in the preparation of an analytical report on the forest situation in the State of Idaho.

Forest Survey

The initial forest inventory of south Idaho will be continued during 1954. If suitable aerial photography and base maps become available, field work in this area should be nearly completed by the end of the year.

All of Montana is now on a maintenance survey basis and field work will continue on a modest scale.

Studies dealing with the techniques of sampling and photo interpretation will be continued. The main objective of these studies is to find the most economical way to conduct the forest survey.

Division of Forest Pathology[2/]

A. Accomplishments in 1953

Research on Pole Blight

1. Field work was limited to observations of existing experimental areas. The major effort during the year was analysis of field data, but no complete results can be reported now. A summary of where we stand in our knowledge of pole blight is timely, however.

   The cause of pole blight has not yet been determined after more than 5 years of concentrated effort by several agencies including the University of Idaho, the Canadian Department of Agriculture, the U. S. Forest Service, and the Division of Forest Pathology. However, we do know approximately where we should now concentrate our efforts. For instance, no fungus organism, isolated from diseased trees and inoculated into healthy trees, has successfully produced pole blight in these individuals. Fertilization trials and other types of nutritional experiments designed to stop the progress of the disease in a tree, to help trees recover, or to hinder the spread of the disorder in diseased stands have shown negative results. Eradication experiments, although still under study and observation, have also met with failure. The limited testing for viruses does not eliminate them as a potential factor. Numerous dissection studies, although partially in conflict, suggest that radial growth reduction occurs prior to the appearance of recognized crown and trunk symptoms. Physiological studies with the use of radioisotopes have indicated a disruption of the translocation system in blighted trees whose trunks possess lesions. Root mortality investigations have revealed significant differences between the root systems of healthy trees and stands compared to diseased ones. One area, presumably blighted at some time in the past and now free of the disease, has recently been reported. This report is the first case of its nature and if verified should cut short many longtime observations that must necessarily be taken on a disease of this nature. In short, and not discounting the possibility that a virus may be the cause, the evidence to date indicates that the trouble appears to

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2/ Cooperating with the Station in 1953. Beginning in 1954, Forest Pathology assumes divisional status.

initiate below ground while previously we have had to deal with the tree as a whole, including all its above-ground aspects. The reduced root system caused by above normal root mortality could be the initial step in the general downgrade of the tree through reduced radial growth and then progressively increased trunk and crown deterioration. The possibility that adverse soil relationships, fungal populations, viruses, or many other known factors contributing to root mortality, could be the first step in this complex problem is yet to be investigated.

Pole Blight Surveys

2. Additional pole blight diseased areas were found. Some 23 new diseased areas were found this past summer. However, the established boundaries of the disease were not extended to any great extent. Aerial scouting was much less last year, with only 25 hours flown. Approximately half of the flying time was spent on remapping and relocating known diseased areas and checking size and spread; the other half was spent on actual scouting in healthy stands or healthy portions of diseased stands.

3. No blight was found farther south and no new areas found near the southern limits. All the major pole stands along and just to the south of the southern limits were closely inspected from roads and lookout points. In addition, these stands were examined by ground crews more intensively than in any previous year. All pole stands in the heart of the Clearwater country were examined from the ground. Also, the several suspected areas on the Clearwater that were carried over from previous years were scouted. No pole blight was found.

4. No symptoms of pole blight were found on the Colville National Forest. All major stands containing white pine poles on the Colville National Forest were surveyed for the first time. This forest is apparently free of the disease.

5. The acreage of white pine pole blight in the United States is now estimated to be between 90,000 and 95,000 acres. Greater efficiency and ability in estimating acreage and extent of damage within a stand are probably the largest contributors to the acreage increase. Visible symptoms have increased and the extent of diseased areas are recognized more readily. In a number of diseased stands, ground reconnaissance has shown the extent of damage to be considerably larger than that viewed from the air. It is possible that more areas, which have not had adequate ground examination, are larger than mapped. The acreage estimate consists mainly of moderate to severe damage but does include some light scattered damage.

6. A survey was made of portions of white pine areas in the Cascade and coastal ranges of Washington and Oregon for the presence of pole blight. Only a few stands were found that warranted close

examination. In all cases suspicious spots turned out to be abnormalities other than pole blight. It can be concluded that there is no pole blight present in western Washington and Oregon in the white pine stands covered by the survey.

B. Plans for 1954

Because of reorganization within the Service and between Services involving the Division of Forest Pathology, the program of work during 1954 has not yet been established definitely. The following plans are tentative.

Research on Pole Blight

1. Initiate virus studies.

2. Study the physical and chemical properties of white pine soil types and their possible relationships to pole blight.

3. In conjunction with the above soil study, continue root mortality studies.

4. Finish analysis work on existing field data.

Pole Blight Surveys

5. Continue some survey activity along the southern limits of the disease.

Forest Utilization Service

A. Accomplishments in 1953

1. Study of Engelmann spruce lumber shipments indicates a wide deviation in lumber grade recovery of individual mills. This and other information was obtained from studies sponsored by an Engelmann Spruce Utilization Committee, formed to aid in the salvage of spruce timber, 15 billion feet of which is threatened by bark beetles. The duty of the committee, organized by the Forest Utilization Service, is to devise ways and means of obtaining necessary utilization data through appropriate studies. Participating agencies are: Western Pine Association, J. Neils Lumber Company, Bureau of Entomology and Plant Quarantine, National Forest Administration, and the Forest Utilization Service.

One of the principal jobs of this committee was to establish trends in grade recovery by months as utilization of bug-struck Engelmann spruce progressed. Data will be obtained from studies of lumber shipments. Such trends indicate the effect of deterioration from bug damage and will enable manufacturers to keep the production of low-grade lumber within tolerable limits by

manipulation of utilization requirements in the woods. Some of the results of this grade recovery study to date are:

1. Mills most experienced in spruce lumber production prior to bug infestation had the highest recovery of select.

2. Production of select lumber varied from 2.1 percent to 10.6 percent.

3. No significant effect of the bug epidemic on average lumber recovery had been noted up to October 1953.

4. It is expected that a substantial grade depreciation will be noticeable by September 1954 unless care is taken to cull badly damaged bug-struck material in the woods.

As a result of a log trimming allowance study some modifications in current utilization standards have been adopted. It is recommended that a standard of 6-inch trimming allowance be used for short spruce logs, 8 to 20 feet. The need for flexibility in utilization requirements is recognized as deterioration of dead timber accelerates. Further studies will provide the basis for other changes in practices if such are required.

2. Western larch poles with counterclockwise spiral grain show less distortion in the top or crossarm section of the pole than those with clockwise spiral grain. Last year's annual report described the western larch pole farm at Newport, Washington. This consists of 40 poles with two replications in each of 20 categories. Forty- and forty-five-foot poles, classes 3, 4, and 5, were used. In the seasoning category there were poles that were green and those that had been seasoned for 1, 2, or 3 years, respectively. In each of these categories two straight-grained poles were installed, two poles having moderate clockwise spiral twist, and two poles with extreme clockwise twist. Counterclockwise twisting of poles with the same spiral modifications were also installed. Results of this project to date are:

a. As a class, the poles with counterclockwise spiral have shown less average twist than poles with clockwise spiral.

b. Poles with severe clockwise spiral grain have been the bad actors. All but two have twisted badly.

c. Considerable variation in twisting or distortion in the crossarm section of the pole occurs within each class. For instance, one pole of severe clockwise spiral twisted over 30 degrees while another pole in the same general class twisted only 6 degrees.

d. Degree of seasoning has not had any appreciable effect on twisting.

e. The poles tend to twist or distort in the direction of spiral during periods of drying and untwist to some extent during wet periods.

Observations of poles under service conditions in lines in the vicinity of Spokane indicate that poles having counterclockwise spiral showed less distortion in the crossarm section of the pole than poles of clockwise spiral grain, bearing out the results of the study at the pole farm.

3. The American Society for Testing Materials inaugurated a $150,000 pole-testing program during 1953 with selection of western larch as the first test species. This cooperative project with the Forest Products Laboratory includes testing of five different pole species; namely, Douglas-fir, western larch, western redcedar, lodgepole pine, and southern pine. The three separate testing phases will be as follows: (1) green shortleaf pine poles will be tested to determine the correlation between crib and machine testing; (2) all species of poles will be tested green to determine the correlation between the strength of green poles and the strength of small clear specimens, and (3) similar tests of poles treated with wood preservative will be made.

   Final selection of 51 green western larch poles was made from pole yards at Sandpoint, Idaho, and Libby, Montana. Sizes of poles selected were as follows:

   28 - Class 6, 35-foot poles of average density
   6 - Class 6, 35-foot poles of high density
   6 - Class 6, 35-foot poles of low density
   6 - Class 9, 30-foot poles of average density
   5 - Class 1 and 2, 60-foot poles of average density.

   Specific gravity density guides used in the selection were: average density approximately .50; low density .42, and high density approximately .55.

   Madison Laboratory and Forest Utilization Service personnel made the selection of the poles which will be tested in the Madison Laboratory one-million-pound testing machine. Poles were inspected according to Western Electric specifications by Western Electric Company inspectors. Local pole producers of the Northern Rocky Mountain area are furnishing $10,000 under a cooperative agreement with the Laboratory for these tests.

4. Specimens for Douglas-fir strength tests were collected from western Montana and northern Idaho. These tests will fill existing gaps in strength data for geographical regions. Douglas-fir from the interior portion of its range has, to date, been considered in the trade as having lower mechanical strength properties than Douglas-fir from the Coast. This means that 2x8 floor joists

of Inland fir must be supplied to equal 2x6 joists of Coast fir. A preliminary analysis of existing data on Douglas-fir throughout its entire range has indicated that there is little or no significant difference in the specific gravity of the species, particularly between the Inland Empire, northern California, and the western Oregon and Washington portion of the Douglas-fir range.

5. Alpine fir was found suitable for groundwood pulp and use in printing papers. Two laboratory reports are now available as a result of work done on this species by the Forest Products Laboratory during the past year. They are: "Experiments on the Groundwood Pulping of Alpine Fir and Use of Pulp in Printing Paper," and "Physical Characteristics and Chemical Constituents of Four Shipments of Alpine Fir Pulpwood."

   These tests were made on four variations of alpine fir, selected as follows:

   1. Wood from the understory of a released and an unreleased larch--Douglas-fir stand.

   2. Mature timber from the Coeur d'Alene National Forest in Idaho, and from the east slope of the Rockies on the Gallatin National Forest.

   The samples cover a wide geographical range. The results of the tests indicate that (1) good quality groundwood pulps can be made from all four of these variations of alpine fir, (2) strength of pulps from the different variations of wood were generally comparable except that the mature wood from the east slope of the Rockies produced slightly weaker pulp, (3) papermaking experiments indicated that good quality printing papers can be made from these groundwood pulps, and (4) unbleached groundwood pulps from alpine fir can be used for production of newsprint papers.

B. Plans for 1954

1. Arrange, execute, and disseminate results of additional studies on the utilization of bug-struck Engelmann spruce. At a meeting of the Engelmann spruce study committee in December, it was decided to continue mill-scale studies in order to show the trend of the deterioration of 1- and 2-year-old bug-struck, dead Engelmann spruce. As a result of previous work there are now:

   1. Experimental spruce logs in the decks of the J. Neils Lumber Company mill.

   2. Experimental spruce trees standing in designated area in Bobtail Creek.

   All of this timber is classed as dead 1952 bug-struck and will be compared with 1952 dead bug-struck logs milled in August 1953. It now appears that it may be desirable to leave top logs of

bug-struck trees in the woods in order to expedite production of logs actually containing bugs, thereby getting quicker control of the epidemic.

2. Study of spiral grain in western larch transmission poles will be continued in cooperation with producers. Observations on the pole farm at Newport, Washington, will be continued and the work probably extended to include the effect of various preservatives on the stability of spiral grained poles. It is hoped this project can be continued for several more years in an effort to verify results of the pole farm study and, if possible, determine application of the data to pole production and management of the timber stands from which poles are cut.

   Observations of individual larch tree characteristics on spirality of grain will be continued on plots established on the Kootenai National Forest during 1953.

3. Testing of Rocky Mountain species for pulp and papermaking properties will continue. As information is developed at the Madison Laboratory, it will be disseminated to interested individuals and agencies. Tests are currently being made on alpine fir and pole-blighted western white pine.

4. Arrange for selection of western larch, western redcedar, and lodgepole pine for cooperative A.S.T.M. and Madison Laboratory pole tests. Approximately 50 poles each of cedar and lodgepole pine must be selected and shipped in green condition for phase 1 of this project. A similar number of treated poles of each species must also be selected. The cedar poles will probably come from the Spokane-North Idaho area, while lodgepole pine poles may be procured in the Libby and Bozeman areas of Montana, and the Denver area in Colorado.

5. Carry on a problem analysis of the forest products industries of southern Idaho, Utah, and other Intermountain areas. Sometime during 1954 the Forest Utilization Service will shift headquarters from Missoula to Ogden, Utah. Some form of problem analysis is essential before adequate liaison can be established between the Forest Products Laboratory and the wood processors of the Ogden area.

Division of Fire Research

A. Accomplishments in 1953

Lightning Fire Research

The lightning fire research program--now known as Project Skyfire--was expanded. During 1953 the Munitalp Foundation and the Station, with the assistance of National Forest Administration and the Weather Bureau, initiated field studies of factors influencing the occurrence, behavior, and control of lightning fires. The information gained forms part of the necessary background for future tests of lightning prevention.

Observers at 25 national forest fire lookout stations participated in a cloud survey. Each day these observers reported on the formation, growth, and movement of cumulus clouds. They also made special observations of the clouds associated with the great high-altitude winds known as the jet stream. Personnel of the survey network attended a special school held at the Region 1 smokejumper training center to prepare for cloud observation duties. The main purpose of the survey was to chart the action of clouds associated with the development of lightning storms. It is expected that the survey will assist in the detection of cloud-breeding areas where lightning storms most often form or grow.

Jet stream winds are often associated with identifiable cloud types. Observations on the Project Skyfire cloud survey network showed that in 61 percent of the test cases the cloud-association method was successful in identifying the presence or absence of jet stream winds at 20 to 30 thousand feet above sea level. Key clouds in the system of tracking winds are cirrus, cirrocumulus, and two types of alto-cumulus. In 16 percent of the 1953 observations, the air aloft was so dry that there were no clouds present and therefore under such circumstances the cloud-association method could not be expected to apply. In 23 percent of the 1953 observations clouds were present, but the main axis of the jet stream was shown elsewhere. It is believed the number of such cases can be reduced by keener cloud observations and improved jet stream mapping techniques. However, the experimental results of charting high-altitude winds through cloud observations has already proved to have great promise. This technique may be of great value in lightning occurrence and lightning fire behavior studies.

Time-lapse motion pictures of clouds were obtained from several lookout stations. During the 1953 fire season four time-lapse cameras, provided by the Munitalp Foundation, were used to photograph cloud action related to thunderstorm development and the jet stream. At Gisborne Mt. Lookout, in the Priest River Experimental Forest, a special sphere camera recorded several weeks of cloud history over a mountainous area. Late in the fire season this same camera was used in the southwestern part of the region where lightning activity is usually most severe. These time-lapse motion

pictures are providing a valuable research tool for studying the life cycle of major cloud types.

Technical assistance increased in lightning fire research. During 1953 the Project Skyfire program benefited greatly from the cooperative technical assistance provided by private and federal agencies. Dr. Irving Langmuir of the General Electric Research Laboratory came to Missoula to assist in training observers in the cloud survey network. Dr. Vincent J. Schaefer of the Munitalp Foundation, and a co-director of Project Skyfire, assisted in all phases of the 1953 program. Schaefer spent five weeks in the northern Rocky Mountains directing the initial phases of the cloud survey. Dr. Paul B. MacCready of the Munitalp Foundation served as a special field assistant for meteorological phases of the program throughout the 1953 fire season and later started preliminary analyses of the cloud survey data. The staff of the Missoula Fire Weather Office of the Weather Bureau assisted in many phases of the research program. One of the major contributions of the Weather Bureau is the furnishing of daily maps of the jet stream.

Fire Danger Rating

New burning index meter tested. During the 1953 fire season a new burning index meter, developed by the Station, was tested on Region 1 and Region 4 national forests and two national parks. Features of the new Model X-7 Meter are a cumulative index which increases during periods of rainfall deficiency, greater sensitivity to severe burning conditions brought about by very low humidity, and conversion tables for estimating burning index at other times and places. The purpose of the tests is to determine the suitability of the meter for rating the severity of burning conditions. Any needed corrections in the meter, shown by the field tests, will be made after which a final model will be proposed for full-scale operational use.

Fire danger rating systems improved. The cooperative program of National Forest Administration and the Station to develop an improved fire danger rating system contributed several significant things in 1953. The replanning of the Region 1 fire danger station network is now 95 percent complete, and 80 percent of the required changes have been made. A preliminary survey was made of fire danger station location problems in Region 4. An improved battery-operated fan psychrometer was developed. Other activities included technical supervision of fuel-moisture-stick manufacturing, operation of a fire weather instrument repair and calibration shop, and assistance in training personnel engaged in fire danger rating operations.

Inflammability and Fire Behavior

Inflammability of one-year-old logging slash was tested at the Priest River field laboratory. In continuation of work begun during 1952, 51 plots were burned which contained light (7.5 tons per acre), medium (20 tons per acre), and heavy (32.5 tons per acre) concentrations of western white pine, western hemlock, western

redcedar, Douglas-fir, and Engelmann spruce slash. As in fresh slash, rate of fire spread increased as weight per acre of fuel increased. Just as presence or absence of needles was the main factor which caused differences in rate of spread between species of fresh slash, so loss of needles was the major cause of reductions in rate of spread with age. Thus Douglas-fir, having lost its needles over winter, fell into the same low rate-of-spread category as hemlock and spruce. On the other hand, rate of spread in white pine and cedar slash was reduced only slightly after a year since those species retained their needles.

The influence of relative humidity on inflammability decreases as amount of logging slash increases. Test slash fires at the Priest River field laboratory have afforded an opportunity to measure the effect of relative humidity on fire rate of spread in light, medium, and heavy fuel concentrations. Plots containing different amounts of slash per acre were burned when relative humidity was increasing rapidly. Results show that high relative humidity quickly reduces rate of spread of fires in light and medium slash, but within the same time limits has no significant effect on fires in heavy concentrations.

Rate of drying of logging slash varies according to exposure to sun and size of wood components involved. Lopped branches and whole tops of young merchantable Douglas-fir trees were allowed to dry on a south slope in full sunlight, under about half shade, and beneath a dense uncut stand. Periodically needle samples were tested for moisture content, and moisture meter readings were taken at two depths in the wood at several points along the trunks of the tops. Needles attached to lopped branches became highly inflammable after two weeks' exposure in full sun but only after three and one-half weeks' exposure in partial or full shade. About eight weeks were required for needles attached to tops in full sun or half shade to become inflammable, while those on fully shaded tops were nearly as moist after ten weeks as at the start of the experiment. Needles which dried rapidly turned brown and remained rather strongly attached to the twigs; those which dried slowly stayed greenish and tended to fall off. Wood moisture content decreased rather rapidly for about six weeks and then leveled off in all tops. At the same time moisture content became approximately uniform throughout the trunk except where lowered somewhat by extreme exposure to the sun. Final wood moisture content in the fully shaded tops was 30 to 35 percent; in the others 20 to 25 percent.

Field tests showed that roofed slash piles can be burned during wet weather at reduced cost. In July, slash was piled with and without paper roofs. Late in November, shortly after the occurrence of nearly 4 inches of rain, the piles were burned. Seventy percent more roofed than unroofed piles could be burned in a given length of time. Labor and related costs could be reduced by about nine cents a pile. While a net cash saving will be realized if the paper for roofs costs less than nine cents a pile, probably the

greatest advantage of using roofs is that the burning of roofed slash piles can be delayed until the occurrence of wet weather when there is no danger of fires spreading.

B. Plans for 1954

A new burning index meter will be completed. It is anticipated that the Model 7 Meter will be ready for full-scale operational use during the 1954 fire season. Along with the meter it is planned to issue a Station Paper on fire danger rating operations. Other work will include: (a) continued work on development of a fire danger rating station with special emphasis on areas in southern Idaho, Utah, and Wyoming, (b) technical supervision of fuel-moisture-stick manufacture, and (c) development of improved fire danger rating equipment.

Logging slash research will be continued. Tests of logging slash inflammability will be continued at the Priest River field laboratory in cooperation with the University of Idaho. If necessary manpower becomes available, slash study plots for four additional species will be installed. A publication on the logging slash problem will be prepared. Studies of the rate-of-drying of logging slash will be continued. Results of tests of roofing slash piles as an aid to burning will be published.

Fire problems of the Intermountain Region will be analyzed. The consolidation of the Intermountain and Northern Rocky Mountain Stations expands the territory of the fire research unit. Preliminary studies will be made of the fire problems in Utah, Nevada, southern Idaho, and northwestern Wyoming, with a view to exploring possible means of providing better research service.

Lightning fire research will be continued. It is anticipated that the field program of the Munitalp Foundation will be expanded to enable more active work in several phases of lightning fire research. A mobile meteorological laboratory is expected to be in use during the 1954 fire season. A cloud survey network will again be operated. Time-lapse motion picture photography of clouds and lightning fire action will be continued from several lookout stations. Special studies will be started of cloud-breeding areas where lightning storms develop. Results of work done to date will be evaluated with a view to early publication of results.

Infiltration Project

A. Accomplishments in 1953

1. Curves for predicting soil moisture content were developed for five soil-vegetation conditions. The infiltration project, at the Priest River Experimental Forest, is the first extension of pilot plant studies for predicting soil moisture content conducted by the Forest Service at Vicksburg, Mississippi, for the

Waterways Experiment Station, U. S. Army Corps of Engineers. The purpose of the studies is to develop methods for predicting the trafficability of soils from a military tactical standpoint. Field work, started in June 1952 at Priest River, was completed on five sites in August 1953. A report covering results of the Priest River studies was submitted to the Vicksburg headquarters of the project in late December. Personnel on the infiltration project in this region have moved from the Priest River Experimental Forest to Spokane, Washington. Spokane will be operating center for the project during 1954.

B. Plans for 1954

1. Soil moisture will be studied at five sites in the Palouse soils near Rockford, Washington. Soil, vegetation, and meteorological factors will be measured for 12 months to provide data for developing methods of predicting soil moisture on five soil-land use combinations.

2. Soil moisture will be studied at three sites near Miles City, Montana, and curves for predicting soil moisture content will be developed for these sites. A report on the Miles City studies will be completed by the end of 1954.

3. Priest River snow studies data will be examined for possible relationship between snow cover and soil moisture.

Division of Forest Management Research

A. Accomplishments in 1953

Natural and artificial regeneration

One of the most important objectives in intensive forest management (perhaps the most vital of all) is the establishment of a new stand promptly following logging. Where possible, natural regeneration is cheapest and best. Where conditions beyond the forester's control prevent restocking by natural means, artificial methods such as planting or seed spotting must be employed. During the past year, several important additions were made to our expanding knowledge of tree seeding habits and to practical methods of capitalizing more fully on natural seed crops.

Large quantities of Engelmann spruce seed were dispersed as far as 9 chains from the timber edge of a clear-cut strip 18 chains wide. These results come from a seed production study being conducted in a block clearcutting in spruce in Falls Creek drainage on the Flathead National Forest. Nearly a million sound seed per acre fell in adjacent uncut timber, while the quantity decreased sharply to 70,000 per acre at 7 chains and a minimum of 60,000 at 9 chains (center of clear-cutting) from the uncut timber edge.

This seed production resulted chiefly from a bumper seed crop in the autumn of 1952, while practically no seed had fallen during the preceding 3 years. Approximately 92 percent of the total seed fall took place by October 15.

These facts point to the need for limiting the size of clear-cut blocks or strips and for taking advantage of good seed crops when they occur. To make effective use of the crop, the seedbed must be prepared prior to seed fall. Preferably, the seedbed should be prepared by September 1 to 15. Since 92 percent of the seed had been released by mid-October, slash burning after that date will destroy the bulk of the current seed crop. Where burning is necessary, it would be more desirable to do it a year in advance of the good seed year than to wait until late October of the good seed year and burn up the seed.

Seed production records show 4- to 5-year intervals between good seed years in western larch. A 5-year seed record from the Coram Experimental Forest shows one good seed year in five as follows:

1949 - fair
1950 - poor
1951 - none
1952 - good
1953 - poor

Earlier studies in the western white pine type by I. T. Haig, based upon a 14-year record, showed an average interval of 4.7 years between good seed years for western larch and Douglas-fir. With such long intervals between good seed years, it is important to provide the seedbed conditions which will make effective use of seed produced during fair and poor as well as good seed years.

Methods of predicting pine cone crops are being improved. As an example of their usefulness, a fair ponderosa pine cone crop is forecast for 1954 in the Kootenai National Forest section of western Montana. The Station has continued testing a method of forecasting ponderosa pine seed crops based upon counts of flowers and conelets. It is necessary to determine the normal mortality of conelets which occurs between the first appearance of flowers and the mature cone two years later. Records for three years are now available. Last year it was forecast that the 1953 crop would be about the same as the 1951 crop (fair). The actual numbers of seed dispersed on the study area in the 1951 and 1953 crops were in close agreement. The following tabulation shows the number of cones developed on tagged sample branches and the seed production record determined from seed traps on the study area.

	Number	Dispersed per acre
Cones matured in 1951	104	10,300
Cones matured in 1952	9	200
Cones matured in 1953	80	10,200
Conelets that will mature in 1954, assuming normal losses due to causes other than squirrel cutting	84	-

The earliest date at which a reliable forecast of the seed crop can be made is about August 1 of the first year that pollination is complete and the flowers have set. By then the early flower mortality associated with abortion and failure to become pollinated will have occurred, and the number of remaining conelets will, with an allowance for normal mortality, form a sound base upon which to forecast the crop. From the August count (above tabulation), reduced for mortality, 84 cones are expected to mature on the sample branches in the fall of 1954. This will be about the same as the 1953 crop.

The successful restocking of western larch--Douglas-fir stands after harvest cutting is highly dependent upon the proper combination of seed source, condition of seedbed, and good growing conditions. A study of harvest cutting methods at Coram Experimental Forest and Blue Mountain on the Kootenai National Forest illustrates the interrelation between the proportion of the ground surface in favorable seedbed, method of cutting (seed source), and stocking by first-year seedlings. The quantity of the seed source is affected by the type of cutting and has an important bearing upon stocking. For example, shelterwood cuttings which averaged a reserved stand of 13 western larch seed trees 18 inches d.b.h. and larger per acre produced from two to five times as many first-year seedlings on comparable sites as seed tree cuttings which left on the average slightly more than 4 seed trees per acre. On the other hand, the rate of stocking is nearly tripled in the seed-tree cuttings and more than doubled in the shelterwood cutting by increasing the amount of favorable seedbed from 10 to 50 percent. In the average logged-over larch-fir stand only 10 to 20 percent of the area is disturbed sufficiently by logging to provide favorable seedbed conditions.

The study indicates that regardless of the method of cutting, a favorable seedbed is requisite to successful regeneration. When such a seedbed does not occur naturally, or is not provided by the logging operation, other means must be employed to improve the seedbed condition. Piling slash with a bulldozer and brush blade, or controlled burning of the slash can accomplish both the exposure of mineral soil and the reduction of competing vegetation.

The quantity of seed is equal in importance to seedbed. One good seed year such as 1952 may provide sufficient seed in any of the described cutting methods during the early years of the regeneration period while the seedbed remains in optimum condition. On

the other hand, during the interval between good seed years, as few as 3 to 5 scattered seed trees per acre will not produce enough seed to stock promptly even highly favorable seedbed. Larger numbers of seed trees per acre (8-10 minimum) will be necessary to offset the lowered production per tree during poor and fair seed years.

Silvicultural Studies

Reference has been made earlier in this report to the close relationship between insects and diseases and many of our more vexing forest management problems. Cooperative attacks on certain disease and insect enemies were carried forward in 1953. Further progress was made in developing and testing harvest cutting and slash disposal methods. Studies of stand improvement measured yielded valuable information.

Studies and activities aimed at reducing timber losses caused by insects and diseases gained impetus. (a) U.S.D.A. Circular No. 919, "Aiding Blister Rust Control by Silvicultural Measures in the Western White Pine Type," a cooperative report by the Experiment Station and the Office of Blister Rust Control, Bureau of Entomology and Plant Quarantine, was published in September. It outlines in detail the occurrence and life history of ribes in forest stands, the incidence and spread of white pine blister rust on ribes and white pine, and the influence of timber-management methods on ribes establishment and growth. (b) The Station again sponsored the annual conference of representatives of all agencies engaged in white pine pole blight research. In addition, a commercial cutting was made in a badly pole-blighted white pine stand on the Priest River Experimental Forest to test the possibility of salvaging pole-blighted material and at the same time obtain a permanent road system for future cuttings. (c) Tests of cuttings to salvage windthrown, insect-infested, and poor-vigor trees were continued successfully on the Deception Creek and Priest River Experimental Forests. (d) Slash disposal was completed on an area to be used in a test of ribes control on the Deception Creek Experimental Forest in cooperation with the Office of Blister Rust Control of the Bureau of Entomology and Plant Quarantine and the Coeur d'Alene National Forest. (e) A start was made on a study to determine the relationship between tree vigor in Douglas-fir and attack by the Douglas-fir beetle in cooperation with National Forest Administration and the Forest Insects Laboratory of the Bureau of Entomology and Plant Quarantine.

Growth and mortality studies in western larch--Douglas-fir cutting trials show an advantage from selecting good-vigor seed trees in shelterwood cutting. The studies are located on Blue Mountain in the Kootenai National Forest. Over a 5-year period the shelterwood cut in which the best vigor reserve was selected grew 51 board feet per acre per year. In a shelterwood cut where the largest trees were removed (economic selection), a loss of 438 board feet per acre resulted (see table).

Growth of residual stands per acre by cutting method (Blue Mountain)

Residual stand	Shelterwood: Vigor selection: Trees	Shelterwood: Vigor selection: Basal area	Shelterwood: Vigor selection: Volume	Shelterwood: Economic selection: Trees	Shelterwood: Economic selection: Basal area	Shelterwood: Economic selection: Volume	Seed tree: Trees	Seed tree: Basal area	Seed tree: Volume
	No.	Sq.ft.	Bd.ft.	No.	Sq.ft.	Bd.ft.	No.	Sq.ft.	Bd.ft.
1948	66.29	93.12	18,773	40.91	39.55	6,935	35.05	32.26	5,366
1953	71.53	95.91	19,028	32.49	30.55	4,746	48.32	36.45	5,410
Net 5-yr. growth	5.24	2.79	255	-8.42	-9.00	-2,189	13.27	4.19	44
Periodic annual growth			51.0			-437.5			8.8

Mortality was caused almost exclusively by windthrow. The losses in the shelterwood (economic selection) were high, with a volume of 2,427 board feet on 12.12 trees per acre lost. The shelterwood (vigor selection) suffered lightly by comparison with only 222 board feet on 4.6 trees per acre lost in five years. Similar cuttings on the Coram Experimental Forest show a similar trend for 2-year mortality.

When mature or overmature larch--Douglas-fir trees are reserved as seed trees or growing stock for further increment, they should be selected from the better vigor groups. Such stands may at least maintain or even increase their volume by the next cut. Since larch generally does not respond well to logging release, high growth rates cannot be expected.

Fire line construction cost made up 55 percent of the total expense of slash disposal and seedbed preparation in alternate strip clearcutting of western larch--Douglas-fir on Coram Experimental Forest. The cutting occupied 78 acres in eight strips 3 to 5 chains wide and varying from 10 to 44 chains in length. They run up and down slopes which average about 30 percent. These narrow strips have a large perimeter in proportion to the area included. Thus, it was necessary to construct 462 chains of fire line to confine the slash burning of 78 acres of cutover strip. Assuming that the cost of the other elements such as bulldozer piling and burning are comparable between cutting methods, the high cost of fire line construction may be a distinct disadvantage in the strip-cutting method. Bulldozer piling comprised 37 percent of the cost and burning of piles 8 percent.

The work consisted of putting a fire line around each strip, piling slash with a bulldozer on slopes up to 40 percent and windrowing slash near the top and bottom of steep pitches. Young, vigorous residual trees were left standing. The burning was accomplished late in the fall, which minimized the need for mop-up and patrol. Items of cost are shown below:

Cost element	Hours per acre	Rate per hour	Cost per acre
Preparation			
1. Fire line building - 462 chains of line by D-7 tractor with angle blade	1.25	$11.35	$14.19
2. Slash piling, D-7 with Isaacson blade	0.83	11.35	9.42
3. Supervision	1.74	1.75	3.04
4. Transportation	-	-	0.20
Burning			
5. Labor	1.02	1.65	1.68
6. Supervision	0.41	1.75	0.72
7. Transportation	-	-	0.06
8. Materials (propane, etc.)	-	-	0.06
Total			$29.37

An intermediate harvest cutting test in 75-year-old white pine near Pierce, Idaho, will provide needed information for stands of this age. Logging was completed in 1953. The experiment, consisting of five treatments (two levels each of crown and selection thinnings and an unthinned control), was established in cooperation with the Clearwater National Forest on an excellent site. Volumes in the stand before thinning ranged from 45,000 to 66,000 board feet per acre.

A study of logging damage on four sets of test-demonstration plots in second-growth ponderosa pine showed that heavy cutting resulted in much greater logging damage than did light improvement cutting. Heavy cutting, similar to most commercial logging in this type of stand in the Inland Empire, removed 75-80 percent of the volume and resulted in loss or injury of 14 trees per acre in the residual stand. Removal of 25-30 percent of the volume in light improvement cuts caused the death or injury of only 4 trees per acre. These results and their importance to management of second-growth ponderosa pine are discussed in Station Research Note No. 121.

In an attempt at mechanical thinning, a bulldozer thinning trial was installed in a 30-year-old western larch-lodgepole pine sapling stand in cooperation with the Nine Mile District, Lolo National Forest. Upon completion the stand appeared jumbled, but subsequent growth and mortality may improve the appearance. A D-6 tractor, with a 12-foot dirt blade mounted straight rather than angled, was employed. The trees were thinned by running the bulldozer down hill (40 percent slope) through the stand, destroying the trees on strips the width of the bulldozer blade (12 feet). Intervening reserves of untouched trees were left. Three spacings were used to give a 2-foot, 6-foot, and 12-foot-wide reserve stand between strips. Windfalls on the ground interfered with the work and frequently caused destruction of the reserve trees for short distances, particularly in the narrow 2-foot reserve. The tractor driver had difficulty in maintaining a uniform width of reserve strip. Costs were relatively low at .6 tractor hour per acre on 12-foot spacing and 1.3 tractor hours per acre on the 2- and 6-foot spacings. Cheap, mechanized methods may be the answer to economically feasible thinning operations in young stands. Much developmental work, both in equipment and in techniques of operation, is needed.

Practical information is being gleaned from various studies of stand improvement in western white and ponderosa pine stands.

a. Records from thinning tests established in 1919 in a 60-year-old western white pine stand on the Priest River Experimental Forest show that light to moderate thinnings increased volume growth slightly and improved the quality of growth. A lightly thinned plot has shown a gross annual increment of 806 board feet per acre since thinning compared to 730 board feet per acre on an unthinned plot and 588 board feet on a heavily thinned plot. Thinning improved the value of the final product by concentrating growth on fewer trees of the most desired species. All the treatments stimulated diameter growth of dominant and codominant trees, but heavy thinning resulted in faster growth than light thinning. The average 10-year diameter growth of dominant and codominant trees on the heavily thinned plot averaged 1.12 inches compared to .98 inches on the lightly thinned plot and .86 inches on the check plot.

Thinning also improved the composition of the stand by increasing the proportion of white pine from 5 to 21 percent. The heavy thinning proved most effective in improving stand quality, but the improvement was made at the expense of total volume growth which was less than that of the lightly thinned and unthinned stands.

The results here are generally similar to those reported in last year's annual report. That is, thinning effectively improves the quality of the final product by increasing diameter growth and by increasing the proportion of high-value white pine. On the other hand, thinning has little effect on total volume growth. The results of this test differ from those reported last year in that light thinning actually increased gross volume production above that of the unthinned stand. The difference in volume growth was not great in either case.

The greatest deterrent to thinning in the western white pine type is that the material removed is not yet merchantable; the cost of thinning must be borne by the final crop. It is generally believed that thinning will not be profitable until a market develops for the thinned material.

b. Fifteen-year records from two sets of thinning plots in 50-year-old ponderosa pine stands near Missoula, Montana, are similar to the results from the thinning tests in western white pine stands. No difference in gross growth on total production was found between the thinned and unthinned ponderosa pine plots. Thinning increased net growth, however. Growth has been concentrated on selected stems. As a result, diameter growth of dominant and codominant trees is considerably greater on thinned than on unthinned plots. This means that trees on thinned plots will reach merchantable size sooner than on unthinned plots.

c. Twenty-four western white pine trees pruned in 1939 and 1940 by various methods were sectioned and studied in detail. Decay was found in 9 of the 24 trees indicating that it may be more serious after pruning western white pine than we have hitherto believed. Wound pruning (cutting into the main stem) did not give any added protection from decay when compared with flush pruning (cutting flush with the main stem) and resulted in greater amounts of resin streak in the wood. It produced only slightly faster healing than flush pruning. In view of these results and because wound pruning takes longer, flush pruning would seem to be the better practice.

d. Pruning time studies conducted on the Deception Creek Experimental Forest show that 37 western white pine trees can be pruned per man-day on the average. Pruning time was recorded on two separate operations. The first study was made in a natural stand about 30 years of age. The second study was conducted in a 17-year-old plantation. Trees were pruned with curved pruning saws in both studies. In the natural stand, trees were pruned in three operations. Men equipped with hand saws pruned as high as they could reach. Pruning was continued with an 8-foot pole saw and was completed to a full log length (16 feet) with a 14-foot pole saw. Following are the lengths of stem pruned and the effort expended per tree for each operation.

Operation	Average length pruned	Average pruning labor per tree
	Feet	Man-day
Hand saw	9.17	.0074
8-foot pole saw	5.22	.0054
14-foot pole saw	5.69	.0143
Total	20.08	.0271

At this rate, 37 trees were pruned per man-day. In the plantation study, pruning required somewhat more time. Only hand saws were used. The trees were pruned to an average height from the ground of 8.5 feet at a labor cost of .0098 man-day per tree.

e. A test to determine the effect of weeding and overwood removal on the development of western white pine and western hemlock reproduction was started on the Deception Creek Experimental Forest. A rather dense stand of mixed reproduction developed following a light shelterwood cutting on a 20-acre tract in 1935. Under the shade of the overwood the white pine in the reproduction was overtopped and suppressed by more shade-tolerant species, chiefly western hemlock and grand fir. In 1952 the tract was divided into two equal units. On one unit the overwood was removed to release the reproduction. On the other unit the overwood was left to shade the reproduction. On both the released and shaded units three weeding treatments are being tested. One-third of each unit will be left untreated. Another third of each unit is being weeded to favor white pine reproduction. On the remaining third the reproduction is being weeded to release and improve the spacing of western hemlock. The growth and development of the reproduction as affected by the various treatments will be followed on a series of sample plots.

Mensuration

While not as well known outside the profession as certain other fields of forestry, forest mensuration is nonetheless an integral part of management research. It involves the measurement of volume and growth of trees and stands, often expressed in terms of usable products. Mensurational knowledge is sometimes taken for granted, but there are many gaps in it which should be filled. The Station helped fill several of them this past year.

Repeated site index determinations on 88 sample plots in second-growth western white pine stands showed that small site index changes have occurred. Multiple regression analysis of 324 five-year growth periods showed that age and site index had a statistically significant influence upon changes in site index; site index at the beginning of the five-year period accounted for most of the change. Density (percentage of normal basal area) and composition index (percentage of stand composed of western white pine and grand fir) were not significant factors. Although small changes did occur, they were so small that site index curves now in use are sufficiently accurate for management use. This study, which was published as Research Note No. 132, has importance outside the white pine type for it involves a basic concept of site index construction and use evaluated by an analysis of long-time plot records.

An analysis of records from 38 permanent plots in second-growth western white pine stands shows that approximately 10 percent of the total board-foot and 20 percent of the total cubic-foot production of the average 100-year stand has been lost through mortality. The 145 pentads, for which accurate mortality data were available, showed that mortality

was extremely erratic. Mortality was positively correlated with age; the older the stand the greater the annual loss in volume. Board-foot mortality was significantly correlated with site index; board-foot losses increased with increasing site quality. Wind and snow damage caused half the total mortality. Other important mortality agents were suppression, insects, and disease.

This study was presented to the annual meeting of the Northwest Scientific Association and a manuscript is being prepared for publication in "Northwest Science."

Composition in western white pine stands is established during the first 30 years and does not change appreciably in a rotation age of 100 to 120 years. This has been found true in a study of 20-year records of 86 permanent plots established in second-growth western white pine stands in northern Idaho. Average 20-year changes in total stand composition (basal area basis) were found to be small. However, individual plot changes showed great variation. Composition changes in the 30- to 100-year stands studied were so small as to have no practical importance. The results emphasize the importance of controlling stand composition during the juvenile stage. Results of the study will be published during 1954 as a station release.

Permanent sample plots in well-stocked stands of second-growth ponderosa pine on excellent sites grew, during a 17-year period, at the rate of over 1,000 board feet per acre per year. The four plots are located on fertile bottomland near Tensed, Idaho. Nearly all land of similar quality has been cleared for agricultural purposes. Although these rapid growth figures are not typical of second-growth ponderosa pine timberlands, they do show the upper limit of growth potential on ponderosa pine sites in the northern Rocky Mountain region. Research Note No. 128, which reports this information, also shows that three of the four plots, all of which are above normal stocking, are approaching normal.

Genetics

The important role that genetics can and will play in the improvement of future forest stands is now pretty generally recognized. Much of the basic work, particularly in the hybridizing phases, is carried on at the Institute of Forest Genetics, California Forest and Range Experiment Station. However, other aspects of the program are becoming more and more regional in scope. In 1953, northern Rocky Mountain tests of lodgepole pine x jack pine hybrids, certain other hybrids developed at the Institute of Forest Genetics, and crosses of local western white pines for blister rust resistance and vigor were continued. Selections were made of ponderosa pine trees which may do well on white pine sites.

One-year-old lodgepole pine x jack pine hybrids from controlled-pollinated seed produced on local lodgepole pine trees are taller than seedlings produced from local wind-pollinated seed. Hybrids were made from trees growing in the St. Joe National Forest in

Idaho and the Lolo National Forest in Montana. Hybrids and wind-pollinated seedlings from Idaho sources were taller than those from Montana sources, but this difference may have been due to seed weight. Average heights and seed weights are shown below.

Seed parent	Pollen parent	Average height of seedlings	Average seed weight
		Feet	Milligrams
Lodgepole pine #1 (Montana)	Jack pine	.07	4.1
Lodgepole pine #3 (Montana)	Jack pine	.09	4.7
Lodgepole pine #3 (Montana)	Wind	.06	4.9
Lodgepole pine Mix1/ (Montana)	Wind	.06	4.7
Lodgepole pine #5 (Idaho)	Jack pine	.10	5.6
Lodgepole pine #7 (Idaho)	Jack pine	.10	4.8
Lodgepole pine #5 (Idaho)	Wind	.08	5.0
Lodgepole pine Mix1/ (Idaho)	Wind	.08	5.1

1/ Seedlings in these lots were produced from a mixture of wind-pollinated seeds taken from several trees.

Seedlings produced from intraspecific crosses among local western white pine trees continued to reflect the vigor of their parents. Correlations between heights of 2-0 seedling progenies and growth rate of their parents decreased slightly over that occurring with the same seedlings one year ago but the relationship is still significant. A new group of progenies grown in 1953 show the same relationship to even a higher degree than those grown in 1952, possibly due to greater variation in growth rate occurring among the parents. These findings are early results of a cooperative project designed to breed blister rust resistant and otherwise superior western white pine trees. The progenies also revealed that:

a. Geographic strains may occur among the parent trees growing in different localities, though not far apart (roughly 1/2 to 50 miles). The following tabulation shows the average height of 1-0 seedlings by locality of the parents for (1) crosses having parents from a common locality, (2) selfed lots, and (3) wind-pollinated lots. All localities are within the St. Joe National Forest and two of them (Middle Fork and Gold Center Creeks) are only 1/2 mile apart but are on greatly different sites.

	Crosses		Selfed Lots		Wind-pollinated Lots	
	Average height	Basis, lots	Average height	Basis, lots	Average height	Basis, lots
	Ft.	No.	Ft.	No.	Ft.	No.
Crystal Creek	.156	34	.133	4	.153	18
Middle Fork	.159	2	.138	1	.175	2
Gold Center Creek	-	0	.118	1	.133	3
Elk Creek	1.43	1	-	0	.152	2
White Rock Springs	1.06	2	.097	2	.130	2

The progenies also showed differences in time of germination which were associated with locality of parents. Progenies having parents from higher altitudes tended to germinate last.

b. Selfed lots exhibited considerable dwarfing. For example, 1-0 seedlings of lot 19 x 19 averaged .129 feet in height while all other lots having tree 19 as the seed parent averaged .141 feet. Five other selfed lots performed similarly, the average effect being roughly a 15-percent reduction in growth.

A start was made toward finding a strain of ponderosa pine suitable for planting as a substitute for western white pine. On many areas where white pine blister rust control is impracticable, foresters need a valuable tree to substitute for white pine. Ponderosa pine is a natural choice. Although its growth requirements are, on the average, considerably different from those of white pine, it often occurs as isolated trees or small groups well within the white pine type. During the year a study plan was prepared for testing the suitability of progeny from selected trees growing well within the white pine type for planting on white pine sites. A number of ponderosa pine trees were selected in four areas and seven were hand-pollinated to insure cross-pollination of flowers. Seed will be collected in the fall of 1954.

Other Activities

In addition to purely investigative work, advice and help on forest management problems were given on a number of occasions to managers of state, federal, and private holdings. Considerable time was also devoted to the development of criteria for judging productivity levels of cutover land for the national Timber Resources Review. Guides were developed, tested, revised, and tested again before being put to actual use. Material was also compiled for other tasks of the Timber Resources Review.

B. Plans for 1954

Natural and artificial regeneration

Continue emphasis upon seed production and dispersal studies in ponderosa pine, larch--Douglas-fir, lodgepole pine, and spruce-fir types. Investigate further the possibility of protection of seed crop against squirrel damage by banding the seed trees.

Prepare for test planting of western larch seedlings being grown at Savenac Nursery. The 1-0 seedlings will be transplanted this year and will be field planted as 1-1 stock.

Continue study of seed crop forecasting method in ponderosa pine, and begin study in larch. Several more years will be required in the ponderosa pine seed forecasting study to accumulate good records of the average mortality which occurs between the flowering stage and cone maturity. The reliability of the forecasting hinges upon the understanding of this mortality factor.

Start a group seed-tree and shelterwood cutting in larch--Douglas-fir stand. This will be installed on a southerly or westerly aspect to study larch regeneration on the more severe sites.

Continue seedbed preparation test in ponderosa pine with J. Neils Lumber Company. It is contemplated that, with the squirrel damage to the seed crop controlled by banding on one block of the experiment, we will be able to observe further the interrelation between squirrels, mice, and seed dispersal.

Complete analysis of data from slash disposal seedbed preparation phases of larch cutting experiments at Coram Experimental Forest. A considerable quantity of data is on hand which will provide information on the germination and early survival of larch and associated species.

Silviculture

Plan initial cuttings and road development on Piquett Experimental Forest. Some volume loss is being sustained on the Piquett Creek Forest, an area containing considerable mature ponderosa pine. It is proposed to log over a substantial portion of it, removing the highest-risk trees and preparing for experimental cuttings to follow. The first cut, a sanitation-salvage, is merely the first step in placing the stand under management and will lead to more intensive studies.

Complete the analysis of logging costs on the block and strip clear-cuttings in Coram Experimental Forest and the light selection cut in a ponderosa pine stand in Lick Creek drainage, Bitterroot National Forest. This will complete logging cost studies in larch--Douglas-fir unless interest develops in the cost relationship of some specific factor.

Complete analysis of thinning experiments in western white and ponderosa pine and prepare final reports. This is a continuation of an analysis, partially completed, of all the station's thinning experiments.

Continue studies of silvicultural means to reduce timber losses caused by insects and disease. Cooperative studies with forest insect and disease investigation divisions of the station and with the University of Idaho and with National Forest Administration will be continued on white pine blister rust, pole blight, Douglas-fir, and mountain pine bark beetles.

Begin a manuscript for U.S.D.A. publication on the silviculture of the western white pine type.

Mensuration

Complete and publish reports on composition changes, mortality, and approach to normality in second-growth western white pine stands and prediction of 10-year growth for second-growth ponderosa pine stands.

Continue study of effects of stand density upon site index evaluation in second-growth ponderosa pine stands. A limited amount of field data was collected last year. Additional field data will be collected during 1954.

Genetics

Continue a small program of pollination on local seed parents to develop hybrids for local use. At the present time there are some 2- and 5-needle pine hybrids in the Nursery. This year seed resulting from 1953 pollinations will be collected as follows: Pinus contorta x P. banksiana, P. ponderosa x P. ponderosa v. scopulorum, P. ponderosa x P. montezumae, P. ponderosa x P. engelmannii, and P. ponderosa x P. ponderosa v arizonica.

Continue cooperative work in the search for and propagation and testing of rust resistant and otherwise superior white pines. Manuscripts dealing with inheritance of growth rate, measurement of phenotype, evidences of geographic strains, and effects of selfing and early performance of hybrids are being prepared.

Continue studies to find a strain of ponderosa pine adapted to western white pine sites.

Division of Wildlife Research[3/]

This is the seventh year of research at this station on the influences of animal life on the forest. These influences are shown by the studies to date to be multifarious and often severe. Mice and chipmunks are eating over 80 percent of the pine seed dispersed in the ponderosa pine forests. Tree squirrels take the seed by the cone-full before dispersal. Deer eat four-fifths of the seedlings that sprout from the few remaining seeds. Porcupines may damage the trees that grow beyond deer reach. We find that each mature pine tree has run a gamut of these wildlife hazards throughout its lifetime. Similar conditions exist in the white pine forests, but these have not been so intensively studied. Current effort is directed not only to further evaluation of wildlife influences, but also toward understanding life histories of the animals so their management and control may be based on sound ecological principles.

A. Accomplishments in 1953

1. Conifer seedlings inside deer-proof fences continue to thrive while outside deer have browsed nearly all of them. Studies in progress since 1946 show that deer are the principal factors in the death of young ponderosa pine and Douglas-fir seedlings. There are relatively few deaths where deer are excluded by the fences. Of these latter deaths, most are caused by site factors such as drouth and insolation. Insects and disease also cause a few deaths. A manuscript is in preparation suggesting to the wildlife and forest manager that perhaps we will have to use temporary fencing, as is done in Europe, to exclude deer locally from forest lands to get a "catch" of reproduction.

   Five years of simulated deer browsing on ponderosa pine seedlings has given us an insight into the effects of browsing on height growth. Growth is retarded in proportion to the intensity and frequency of browsing and the age of the seedling when browsing started. To cite two examples: Trees three feet tall that received a general clipping every third year (one half the twigs clipped) were 6.6 feet tall at the end of five years--one foot shorter than comparable trees that were not clipped. This is a significant difference. Trees one foot tall at the start and clipped "generally" (one half the twigs) each year were only 1.9 feet tall after five years, while their paired controls were four feet tall. Other intensities and frequencies of clipping and age classes showed commensurate responses. Also, some seedlings that were lightly clipped (terminal shoot only) at less frequent intervals (every other or every third year) showed no significant growth retardation after five years of treatment. These findings will help to evaluate the effects of deer browsing as observed in nature.

3/ The services of a Wildlife Research Biologist are maintained at the Northern Rocky Mountain Forest and Range Experiment Station by the U. S. Fish and Wildlife Service.

2. Beyond the discovery that mice (Peromyscus) eat over 80 percent of the pine seed, we are finding that mouse abundance may actually be regulated to a large extent by the number of seed disseminated from year to year (table 1). Mouse and seed numbers diminished from 1948 to 1951. In 1952 mouse and seed numbers

Table 1. Number of mice caught per trap line and number of seeds dispersed per acre as estimated from seed trap data

Mice per trap line	1948	1949	1950	1951	1952	1953
Spring		38	18	8	13	16
Fall	52	35	12	6	11	16
Seed dispersed per acre the previous fall		75,600	7,800	200	10,400	200

increased together. Only in 1953 did the trends become discrepant; the mice increased slightly in the face of a marked decrease in seed numbers. Further studies should be of value in tracing this relationship. Such information will help in planning rodent control during periods of forest regeneration.

3. Snowshoe hares on Bull Island in Flathead Lake show marked preference for the Douglas-fir forest over the more open ponderosa pine forest. This is because they need dense cover for protection from their main predator, the great horned owl. During the summer of 1953, 25 females gave birth to an average of three litters of young, three young per litter--a total of nine young per female, 225 young altogether on the 100-acre island. The mortality rate was high, so that by midwinter less than 100 hares were left and these may be expected to number about 50 at the start of next spring's breeding season. Summer food consisted of less of the tree and shrub species and more of the annuals. Damage to forest reproduction is thus primarily a winter problem.

A current study will provide a factor for converting fecal pellet numbers to hare numbers. Thus, the pellets, which are more easily seen and counted than the hares, can be used to estimate hare populations. Hares produce between 200 and 300 fecal pellets per day.

Disease studies of ticks from hares this summer revealed no disease present. A fungus infection (ringworm) occurred in the hares this fall. Most cases were mild. One hare only is known to have died, possibly as a result of the infection. "Trap sickness" caused some other deaths. This has many of the symptoms of the so-called shock disease which is thought to be the cause

of periodic hare die-offs. Autopsies of hares that died of trap sickness revealed some symptoms that were different from the symptoms of shock disease.

B. Plans for 1954

1. Deer studies

We will continue exclosure surveys in order to follow the development of seedlings which are still competing with shrubs and herbs that are also benefited by protection from deer. Also the study will be extended to the exclosures at Dunn and Butler Creeks on the Kootenai National Forest as soon as seedlings appear there. These exclosures were not studied this year because not enough seed was disseminated to produce seedlings.

2. Mouse studies

Mouse censuses in conjunction with seed trap and germination surveys will be continued. These studies were extended to Dunn and Butler Creeks in the fall of 1952 and will be continued along with the Bluesky project, which has been continuous since 1948.

3. Snowshoe hare studies

The natural history of the hare will be studied through a full annual cycle with emphasis on techniques for measuring population perameters and habitat use. A full report is to be written and will provide a basis for future experiments in animal ecology to be done on islands in Flathead Lake. These experiments will be directed toward an understanding of the natural forces that regulate the animal numbers.

Division of Range Research

A. Accomplishments in 1953

Artificial Range Revegetation

1. Orchardgrass and seven wheatgrasses proved best adapted to cutover ponderosa pine sites near Spokane, Washington, when spring planted. Three strains of crested, intermediate, beardless bluebunch, Primar slender, and pubescent wheatgrass produced successful stands of uniformly distributed vigorous plants in all spring plantings on severely deteriorated cutover ponderosa pine sites. Another group of species--bluestem wheatgrass, Siberian wheatgrass, Manchar smooth brome, tall fescue, and hard fescue--produced equally thrifty plants but they were unevenly distributed within the rows. Reseeding in the ponderosa pine type in Northeast Washington, using these proven species, will greatly increase herbage production and thereby enhance the

return from these lands through grazing until the next crop of trees can be harvested.

2. Broadcast seeding provided successful stands of several forage species on freshly burned lodgepole pine sites. The possibility of converting "doghair" lodgepole pine to forage producing sites was tested on the Colville National Forest by slashing and burning small test areas which were later seeded to forage species. Big bluegrass, sheep fescue, tall oatgrass, redtop, and timothy produced the best stands. These species should be seeded for watershed protection and to increase herbage production on any lodgepole pine area in Northeast Washington following accidental fires.

3. Plans and field installations were completed for initiation of the first Region 1 study of grazing values with reseeded species. This grazing trial is taking shape on the Dutch Bremner ranch near Republic, Washington, and the first grazing by Hereford cows and calves will coincide with the 1954 growing season. The trial includes a comparison of abandoned, plowed land supporting cheatgrass and weeds with established stands of crested, intermediate, and pubescent wheatgrasses, and smooth brome.

4. Fifteen reseeded forage species were preferred by cattle over the native Idaho fescue and thickspike wheatgrass in a utilization study on the Beaverhead National Forest. During a three weeks' period beginning July 1 cattle grazed 18 and 39 percent, respectively, of the total plants of the two native grasses, and from 73 to 100 percent of all the plants of the reseeded species. This preference for reseeded species became evident immediately and continued throughout the trial. This information not only indicates the comparative grazing value of reseeded and native forage species but shows that closely controlled management is essential in obtaining the best use of reseeded species over a long period.

5. The 4-foot tandem disk with adaptations for horse traction proved to be the most efficient and best adapted implement for seedbed preparation in poorly accessible, high elevation areas. Addition of a tongue and set of trucks to this disk minimized its tendency to "crawl" on sloping sites and provided better control of depth settings on the cutting blades. From 1½ to 3 hours were required to disk an acre in the recent trials on the Gallatin National Forest, depending upon the depth to which the disks were set. This machine, which is highly portable and easily packed, perhaps opens the way to the successful reseeding at reasonable cost of many high areas that are producing less than their potential.

Management of Summer Ranges

6. The Vigilante Experimental Range was stocked again with about 150 head of mixed cattle for a 135-day period beginning June 12. Cattle gains were comparable to those recorded in 1952 even

though the season was 8 days shorter than in 1952 and extremely adverse for optimum herbage production. Daily gains of 1- and 2-year-old heifers and calves averaged slightly more than two pounds per head over the season. Wet cows averaged 1.6 pounds per head per day for the entire season even after suffering a 40-pound average loss during October.

7. Summer calves on the Vigilante Experimental Range were 180 pounds lighter on the average at the close of the 1953 grazing season than calves born before the season opened June 12. This finding, revealed first in 1952, indicates the possibility of increasing beef production with fewer breeding cows and a consequent lighter grazing load on the range simply by regulating breeding. Two-thirds of the breeding cows run at Vigilante could produce more weaned calf weight, than the entire herd does at present, if they were all bred to calve in April and shy or off-season breeders were eliminated. Regulated early breeding throughout Region One would increase beef production, reduce the grazing load on both the national forests and the ranches and materially facilitate management of national forest ranges. Too many Region One permittees still operate on a promiscuous basis so far as animal breeding and management practices are concerned.

Management of Short-grass Ranges

8. The rate of range stocking study on Northern Great Plains experimental ranges near Miles City was continued for the 21st consecutive year. The rotation of heifer offspring into the experiment for the determination of rate of stocking effects on successive generations of Hereford cattle was completed through the sixth year in accordance with plans. To date this experiment has shown a close inverse relationship between rate and amount of growth in both cows and calves and increasing rates of range stocking. The following tables indicate this relationship.

COW WEIGHT

Year	Age	Average summer weight in pounds by stocking intensities		
	Years	Heavy	Moderate	Light
1948	1	630	640	651
1949	2	795	826	853
1950	3	899	949	988
1951	4	918	1006	1055
1952	5	1011	1099	1144
1953	6	1062	1100	1155

CALF WEIGHT

Average weigh date	Seasonal weights by stocking intensities based on 4 calf crops		
	Heavy	Moderate	Light
Birth (average approx. April 15)	71.1	73.3	75.4
May 15	125	136	141
June 12	167	181	189
July 11	225	239	250
August 8	275	295	307
September 5	324	353	361
October 3	362	400	410
October 22	373	422	435

Noxious Plant Control

9. Mulesears Wyethia, an unpalatable, vigorous forb, can be controlled on range lands by spraying with 2,4-D. On small test plots 0.6 and 1.0 percent solutions of isopropyl ester of 2,4-D gave nearly 100 percent kills. Four years later no reinvasion of the plots had occurred. In a large pilot test a 0.2 percent solution of 2,4-D ester applied at the rate of 90 gallons per acre gave satisfactory control, 60 percent removal, of Wyethia. Two years after spraying native grasses had increased 76 percent in desnity.

10. Sierra larkspur succumbs to effects of soil sterilants but effectively resists hormone sprays. In tests on national forest range every larkspur plant treated with common stock salt, borascu, or Polybar-chlorate in 1952 failed to reappear in 1953. These plants were considered unmistakably dead. On the other hand, all but a very low percentage of the plants treated with hormone sprays revived and grew well during 1953.

11. Commercial borax applied in the spring at the rate of 4 pounds per square rod with cyclone seeders will give effective control of goatweed (Hypericum perfoliatum) for two or three years. Prohibitive on large areas because of high costs and difficulties of application, borax is most useful in preventing spread and in controlling outpost infestations. No other control method is practicable in such situations.

B. Plans for 1954

Artificial Range Revegetation

1. Study management of reseeded ranges by grazing established individual species stands on Bremner ranch near Republic, Washington. Grazing of these areas with cows and calves will provide information on species grazing values and indicate profitable means of

filling the gap between winter feeding and national forest summer range.

2. Continue study and observation of grazing values of reseeded species in contrast with native forage species on Dry Fawn area. Continuation of this area study, at least through 1954, will strengthen the position of reseeded range as an integral part of yearlong livestock operations in Montana and as an aid to range management on national forests.

Management Summer Ranges

3. Continue the stocking of the Vigilante Experimental Range and the collection of related cattle weight data as a means of strengthening the case for better livestock and range management practices both on the ranches and the national forests. Elimination of unsound practices revealed by this study will permit greater beef production with less cost and less wear and tear on national forest ranges.

4. Initiate field work needed for planning and eventual initiation of grazing management study on the Smackout area of Colville National Forest. This area offers a unique possibility for study of stocking rates, seasonal use, and other management practices on meadow and adjacent timbered range as well as the potential integration of forage and timber production on the same acres.

Publications Issued During 1953

Jemison, George M.
Forest and range research in the northern rocky mountains. Proc. Mont. Acad. Sciences: 13:89-93. 1953. (A description of the research work of the Northern Rocky Mountain Forest and Range Experiment Station in forest, range, and water resource management; timber products utilization; forest economics; and fire protection. Examples of detailed studies illustrate the approach being followed in each field of work.)

Division of Forest Economics Research

Camp, H. W. Jr.
Pole production in 1951. Research Note No. 130. December 1953. (A report on the number of poles produced during the year from the forests of Montana, North Idaho, and Northeast Washington. Distribution of production by A.S.A. classes is given.)

The spruce bark beetle in the northern rocky mountain region. Proc. Industrial Waste Conference. April 1953. (A paper describing the bark beetle attack and problems of utilization accompanying this epidemic.)

Problems of resource development associated with the construction of large dams. Proc. Pacific Northwest Trade Assoc. November 1953. (A paper describing the impacts of large dams on management of the natural resources, and on the local economy.)

Montana's forests, Montana Conservation Handbook. 1953. (A brief description of Montana's forest resource and its importance to the economy of the state. Designed and written for use by grade school teachers.)

Hutton, Gordon A.
Timber mortality--a loss to Montana's economy. Proc. Montana Acad. Sciences, Vol. 13. 1953. (Describes losses in the timber resource according to causes. Discusses what has been done in the past, what is being done now, and what must be done in the future to reduce these losses.)

Robertson, Forbes; Camp, Harry W., Johnson, Leon H., and Sahinen, Uuno M.
Raw materials of Montana. Industrial and Engineering Chemistry, vol. 45. November 1953. (A paper reporting on the raw materials of Montana, including minerals, oil and gas, coal, nonmetallic minerals, forest products, and agricultural resources.)

Roe, Arthur L. and Hutchison, S. Blair
Montana's Christmas tree producing industry. Lake States Timber Digest. December 1953. (An article describing Montana's Christmas tree industry, stressing problems, and progress made in growing Christmas trees.)

Webb, C. S., Gano, Ward W., Logan, Paul, and Hutchison, S. Blair
Impact of the proposed Libby Dam upon the forest economy of Lincoln County, Mont. Proc. August 1953. (A report to the Corps of Engineers. Report prepared by a four-man team consisting of a forester, road engineer, logging engineer, and forest economist. The report is primarily concerned with the disruption of resource development behind the proposed Libby Dam which would be caused by the reservoir, and the measures necessary to minimize the adverse impacts.)

Wikstrom, John H.
Montana Christmas tree shipments down in 1952. Research Note No. 117. February 1953. (A report on the 1952 Christmas tree business in Montana. Production in 1952 was less than in any of the four preceding years.)

Strip sample versus circular plots for measuring mortality. Research Note No. 120. June 1953. (This report points out that, based on a field test, circular plots are preferable to sample strips for measuring mortality when working with one-man crews. Statistical test proved differences in volume estimates to be insignificant.)

Division of Forest Fire Research

Fahnestock, George R.
Inflammability of the current year's logging slash. Research Note No. 124. August 1953. (Plots containing light, medium, and heavy concentrations of slash cut early in the summer were burned late in August. Amount of slash per acre proved to be the main factor affecting fire rate of spread. The rate increased as weight of slash per acre increased. In light concentrations, fire spread much faster if the needles had not fallen from the slash; in medium and heavy concentrations rate of spread was influenced little, if at all, by presence or absence of needles.)

Chipping takes the hazard out of logging slash. Research Note No. 125. August 1953. (Slash which had been put through a portable chipper burned like duff or litter--much slower than similar concentrations of untreated slash of the same species. Degree of compactness affected rate of spread strongly, while amount of slash meant little. Therefore, the fastest spread was in white, ponderosa, and lodgepole pine chippings, which were relatively uncompacted because the long needles came through the chipper whole. Chipped slash of any species would burn only during the middle of a hot, dry day.)

Fahnestock, George R.
Relative humidity and fire behavior in logging slash. Research Note No. 126. August 1953. (When logging slash was being burned experimentally during the early evening, the rapid increase in relative humidity caused fire rate of spread to decrease significantly in light and medium slash. Increasing humidity had no appreciable effect on rate of spread in heavy slash.)

Hardy, Charles E.
Half-inch fuel moisture sticks -- how they are made. Fire Control Notes. October 1953. (The article gives a short history and tells of the use of fuel moisture sticks. Requirements of original stock are stated. This is followed by a description of the process of sorting, culling, assembling, drying, trimming, and testing. Photos illustrate the various phases of the job.)

Infiltration Project

Holland, James C.
Infiltration on a timber and burn site in northern Idaho. Research Note No. 127. October 1953. (Artificial rainfall was applied at the rate of about 4 inches per hour on a planted 1935 prescribed burn and an adjacent 200+ year old stand of western hemlock, both on the same soil series. Surface runoff began in 15 minutes or less after the start of rainfall on the burn site. Slightly over 14 inches of water applied in 4 hours in the old-growth stand failed to produce surface runoff. The difference in infiltration rates was ascribed to differences in the amount of ground cover.)

Palpant, E.H., Thames, John L., and Helmers, Austin E.
Switch shelters for use with soil moisture units. In Soil-moisture measurement with the fiberglas instrument. Occasional Paper 128, Southern Forest Experiment Station. February 1953. (Gives a description of switch shelters and a portable switching unit used in measuring soil moisture with fiberglas soil moisture instruments. Above-ground wooden shelters are satisfactory in dry climates. Waterproof construction is necessary in wet climates. Portable switching units are satisfactory and inexpensive for large installations.)

Division of Forest Management Research

Bingham, R. T., Squillace, A. E., and Duffield, J. W.
Breeding blister-rust-resistant western white pine. Jour. Forestry, vol. 51. March 1953. (A project was described which was designed to breed blister-rust-resistant and otherwise superior western white pine trees mainly through selection, intraspecific crossing, progeny testing, and propagation of local trees. Details of work accomplished to date and some plans for future work were given. Several agencies in the U. S. Dept. of Agriculture participated in the program.)

Boe, Kenneth N.

Western larch and Douglas-fir seed dispersal into clearcuttings. Research Note No. 129. December 1953. (Ample seed will be dispersed up to 6 chains (3 tree heights) from the timber edge for western larch and 4 chains (2.5 tree heights) for Douglas-fir if one good seed crop matures during the regeneration period. Beyond these distances and up to 12 chains from the source, the quantity of seed may not be sufficient for prompt regeneration.)

LeBarron, Russell K. and Jemison, George M.

Ecology and silviculture of the Engelmann spruce-alpine fir type. Jour. Forestry, Vol. 51. 1953. (Silvical characteristics of Engelmann spruce and alpine fir are discussed in some detail. Silvicultural practices are shown to vary in different parts of the West. For Idaho, Montana, and northeastern Washington, even-aged management is recommended for most situations. Clear cutting in comparatively large blocks of about 40 acres is suggested, with the blocks arranged so as to reduce windthrow susceptibility. Control of shrubs and scarification of seedbed are necessary in some instances. Planting or direct seeding must be resorted to if natural regeneration is inadequate.)

Lynch, Donald W.

Money grows in old pine woods. The Washington Farmer. April 2, 1953. (The establishment and early history of three demonstration plots in 90-year-old ponderosa pine on a ranch near Chewelah, Wash. are described. One is a control plot with no cutting. A second plot is "chopper's choice," which is not good forestry but commonly followed in the area. The third is a light cutting, including a combination of thinning, cutting to improve growth, and removal of beetle-infested trees. In addition to the demonstration value of these farm woodland tests, valuable growth data will be obtained. Money values received in the first cuttings and expected through future growth are given.)

Logging damage increases under heavy cutting of second-growth ponderosa pine. Research Note No. 121. May 1953. (The data for this study were obtained from four sets of test-demonstration plots established to determine the best management practices for second-growth ponderosa pine in the Inland Empire. Heavy cutting, which removed 75 to 80 percent of the merchantable board-foot volume, caused considerable damage to residual trees. Less damage occurred with light improvement cutting that harvested 25 to 30 percent of the merchantable volume.)

Growth of ponderosa pine on best sites. Research Note No. 128. December 1953. (Seventeen-year growth records on 4 fifth-acre plots in second-growth ponderosa pine stands disclose the rapid growth that may be obtained from fully stocked stands on excellent sites. Three of the plots produced over 1,000 board feet per acre per year, and the fourth plot over 2,000 board feet per acre annually.)

Moss, V. D. and Wellner, C. A.
Aiding blister rust control by silvicultural measures in the western white pine type. U.S.D.A. Circ. No. 919. September 1953. (This is a comprehensive report on the present knowledge of the correlation of timber management and blister rust control. A summary of ribes ecology is presented. Partial and clearcuttings in mature and over-mature stands are discussed in relation to blister rust control. The use of prescribed broadcast burning to aid in ribes elimination is covered. Cultural measures in immature stands and their effect upon blister rust problems are set forth.)

Roe, Arthur L. and Squillace, A. E.
Effect of cutting methods on logging costs in larch--Douglas-fir. Jour. Forestry, vol. 51. November 1953. (An analysis of the effect of three methods of cutting (shelterwood, economic selective, and seed-tree) upon the cost of logging was presented. Both the initial cut and subsequent cuts were studied to provide a comparative cost of total liquidation of the old stand in each method. Partial cutting increased the cost of logging.)

Squillace, A. E.
Effect of squirrels on the supply of ponderosa pine seed. Research Note No. 131. December 1953. (A preliminary study of squirrel damage to ponderosa pine seed crops on the Kootenai National Forest in western Montana showed that squirrels cut from 60 to 89 percent of the cones in poor and fair years. The need for some form of control was pointed out. A banding technique now being tested gives some promise of success.)

Watt, Richard F.
Site index changes in western white pine forests. Research Note No. 132. December 1953. (Growth records on 88 permanent sample plots were analyzed to determine whether changes in site index had occurred over a 20-year period. The data, derived from 324 five-year measurement periods, disclosed that slight changes in site index had occurred. Apparently these changes were due to minor errors in the curves used for determining site index. The changes were small enough to be unimportant in practical forest management work.)

Division of Range Research

Evanko, A. B.
Forage species and planting seasons for reseeding cleared and abandoned ponderosa pine areas in northeastern Washington. Research Note No. 119. May 1953. (Seven wheatgrasses and orchardgrass planted in spring produced satisfactory stands under prevailing conditions. Other species and other seasons of planting were unsatisfactory.)

Evanko, A. B.
Performance of several forage species on newly burned lodgepole pine sites. Research Note No. 133. December 1953. (Lists several forage species which produced satisfactory stands from broadcast seeding after burning and recommends five for use following accidental or wild fires in lodgepole pine.)

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A test of borax control of goatweed. Research Note No. 134. December 1953. (Presents results obtained with application of 4 pounds of borax per square rod.)

Division of Range Research
Research Hi-Lites, February 20, 1953
Research Hi-Lites, June 29, 1953
Research Hi-Lites, August 19, 1953

Peterson, Roald A.
Comparative effect of seed treatments upon seedling emergence in seven browse species. Research Note No. 114. January 1953. (Presents results of laboratory tests with seed of seven native species.)

_____
Comparative effect of seed treatments upon seedling emergence in seven browse species. Ecology, vol. 34. October 1953.

_____
Forage plants in a Montana high altitude nursery. Research Note No. 115. February 1953. (Groups tested species into five success groups based on their growth performance over a 10-year period at 9,350 feet elevation.)

_____
Forage plants in a Montana high altitude nursery. Jour. Range Management, vol. 6. July 1953.

_____
Cliff Lake Natural Area. Proc. Mont. Acad. Sciences. Vol. 13. 1953. (Advances need for natural areas and described 2,300-acre area in Beaverhead National Forest withdrawn from use by U. S. Forest Service in 1952.)

Schmautz, Jack E.
Beef production on mountain summer ranges. Research Note. No. 118. April 1953. Indicates value of national forest summer range in terms of beef production.)

Short, Laurence R.
New equipment for the 3-step method. Jour. Range Management, vol. 6. May 1953. (Described development of improved equipment and gives specifications.)

Woolfolk, E. J.
Goatweed threatens Montana ranges. Montana Woolgrower, vol. 27 January 1953. (Describes goatweed invasion as one of major range problems facing Montana woolgrowers.)

_____ Cattle gains show value of summer range. Western Livestock Reporter, vol. 13. Jan. 21, 1953. (Shows value of summer range in terms of beef production.)

_____ Some observations on a white-tail deer winter range in Idaho. Research Note No. 116. February 1953. (Evaluates browse range for deer in winter based on composition and abundance of browse vegetation.)

_____ Range improvement through reseeding. Western Livestock Reporter, vol. 13. Feb. 18, 1953. (Points out possibilities for improving ranges by reseeding.)

_____ An overview of the range situation. Western Livestock Reporter, vol. 13. April 8, 1953. (Evaluates current range situation in view of high livestock numbers and unfavorable weather.)

_____ The effects of breeding season on calf weights and calf crop. Western Livestock Reporter, vol. 13. May 27, 1953. (Shows how regulated breeding can increase size and number of range calves.)

_____ Reseeding requires careful choice of species. Western Livestock Reporter, vol. 13. June 10, 1953. (Points out that a given forage species is best adapted to certain conditions and should not be expected to fill all needs in other situations.)

_____ Northern Great Plains still in drought danger. Western Livestock Reporter, vol. 13. July 29, 1953. (Points up the fact that drought danger not yet past and cautions against loading plains ranges with drought cattle from Texas and southwest.)

_____ Washington farmer profits by research. Western Livestock Reporter, vol. 13. August 19, 1953. (Cites recent accomplishments in reseeding by Dutch Bremner and traces impetus to Northern Rocky Mountain research.)

_____ and Holscher, Clark E.
Forage utilization by cattle on northern great plains ranges. U.S.D.A. Circ. No. 918. June 1953. (Reports study of utilization on cattle range and recommends proper levels for important species.)

PERSONNEL

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S. Dagmar Nelson	Secretary
Joanne C. Helding	Clerk-Stenographer

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DIVISION OF RANGE RESEARCH

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Walter R. Houston	Range Conservationist
Jack E. Schmautz	Range Conservationist
Robert F. Buttery	Forestry Aid (Res.)
Katherine E. Lamoreaux	Clerk-Stenographer

DIVISION OF FOREST ECONOMICS

Harry W. Camp, Jr. (Chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Paul D. Kemp	Forest Economist
Gordon A. Hutton	Forester (Mensuration)
John H. Wikstrom	Forester (Mensuration)
Robert E. Buckman	Research Forester
Henry J. Pissot	Forestry Aid (Res.)
Harold E. Hanson	Forestry Aid (Res.)
Roscoe B. Herrington	Forestry Aid (Res.)
Martin E. Reed	Forestry Aid (Res.)
Monica E. Hobe (Transferred R-10 12-6-53)	Clerk-Stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (Chief)	Forester
Hilda C. Griffiths	Clerk-Stenographer

DIVISION OF FOREST FIRE RESEARCH

Jack S. Barrows (Chief)	Forester (Fire Res.)
George R. Fahnestock	Forester (Fire Res.)
Charles E. Hardy	Forester (Fire Res.)
John H. Dieterich	Research Forester
Paul B. MacCready	Collaborator
Vincent J. Schaefer	Collaborator
Drucille H. Otterson	Clerk-Stenographer

INFILTRATION PROJECT

Austin E. Helmers (In Charge)	Forester (For. Inf.)
Raymond J. Boyd	Forester (Silv.)

INLAND EMPIRE RESEARCH CENTER

Charles A. Wellner (Leader)	Forester (Res. Adm.)
Donald W. Lynch	Research Forester (Gen.)
Anthony B. Evanko	Range Conservationist
Marvin W. Foiles	Forester (Silv.)
Richard F. Watt	Forester (Silv.)
John H. Dieterich	Research Forester
Ernest E. Hubert	Collaborator
Vandella I. Gordon	Clerk-Stenographer

UPPER COLUMBIA RESEARCH CENTER

Arthur L. Roe (Leader)	Forester (Silv.)
Kenneth N. Boe	Forester (Silv.)
Anthony E. Squillace	Forester (Silv.)
Charles W. Waters	Collaborator
Marie Van Loon	Clerk-Stenographer

FIELD STATIONS

Deception Creek	(Coeur d'Alene, Idaho)	Marvin W. Foiles
Priest River	(Priest River, Idaho)	John H. Dieterich
Coram	(Coram, Montana)	Kenneth N. Boe
Northern Plains	(Miles City, Montana)	Walter R. Houston
Vigilante	(Alder, Montana)	Jack E. Schmautz

FOREST PATHOLOGY

(In cooperation with Division of Forest Pathology,
Bureau of Plant Industry, Soils, and Agricultural Engineering)
Charles D. Leaphart, Missoula, Montana
Donald W. Graham, Spokane, Washington

FOREST WILDLIFE

(In cooperation with Fish and Wildlife Service,
Department of Interior)
Lowell Adams, Missoula, Montana

FOREST INSECT CONTROL

(In cooperation with Bureau of Entomology & Plant Quarantine)
James C. Evenden, Coeur d'Alene, Idaho.